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**Type of Organization:** College or University

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**Project Title:** Local vs. non-local sources of atmospheric contaminants

**Project Category:** Pollution Prevention and Reduction - BNS

**Rank by Organization (if applicable):** 0

**Total Funding Requested ($):** 118,823 **Project Duration:** 2 Years

**Abstract:**

Apart from point source inputs to Areas of Concern, atmospheric deposition is the major source of most organic contaminants to the Great Lakes. The Lake Management Plans for all of the Great Lakes call for considerable effort to be made to quantify the amounts of priority pollutants used in each lake basin. Such effort is a waste of resources if the amounts of pollutants used in the lake basins have no bearing on the amounts of pollutants entering the lakes. Furthermore, considerable resources are invested in the Integrated Atmospheric Deposition Network (IADN) for monitoring of atmospheric inputs to the Great Lakes. However, because this monitoring strategy pays no attention to meteorological conditions, it is likely that the estimates of deposition are grossly inaccurate for all compounds that enter the lakes primarily via gas exchange. In this project, it is proposed to demonstrate the effects of meteorological conditions on rates of gas exchange, and then to re-examine the entire IADN database and correctly calculate the rates of gas exchange. These analyses combined with back trajectory calculations will allow estimation of the fraction of the pollutant inputs that are derived locally (within lake basin), from Canada, or from distant sources. Without such information on pollutant sources, it is impossible to devise appropriate control strategies for these persistent bioaccumulative toxins.

**Geographic Areas Affected by the Project**

**States:**

- [x] Illinois
- [x] Indiana
- [x] Michigan
- [x] Minnesota
- [x] New York
- [x] Pennsylvania
- [x] Wisconsin
- [x] Ohio

**Lakes:**

- [x] Superior
- [x] Huron
- [x] Michigan
- [x] Erie
- [x] Ontario
- [x] All Lakes

**Geographic Initiatives:**

- [ ] Greater Chicago
- [ ] NE Ohio
- [ ] NW Indiana
- [ ] SE Michigan
- [ ] Lake St. Clair

**Primary Affected Area of Concern:** All AOCs

**Other Affected Areas of Concern:**

***For Habitat Projects Only:***

**Primary Affected Biodiversity Investment Area:** All BIAs

**Other Affected Biodiversity Investment Areas:**

**Problem Statement:**

Despite bans on the production and use of several persistent bioaccumulative toxins in the U.S., these compounds are still found in fish in high enough concentrations to warrant fish advisories in all of the Great Lakes and to cause developmental ailments in children. Although concentrations of these PBTs have declined in most fish species over the past two decades, current estimates predict that another 10 to 30 years will be required before fish advisories can be lifted. The accuracy of those predictions depends on the accuracy of the estimated rates of input of the PBTs to the Great Lakes.

It is well known that atmospheric deposition is a major mechanism for the input of many of these PBTs to the Great Lakes. For Lake Superior, in particular, atmospheric deposition is the primary source of PBTs. Some fraction of these contaminants are generated "locally" within the watershed of the lake; a large portion of the input, however, is thought to be derived from long-range transport from distant industrial areas or even from Mexico and central America. From a regulatory standpoint, there is clear benefit to being able to distinguish between these sources. It will be very difficult to reduce the long-range transport of pollutants generated in other countries. However, regulatory agencies could adopt different strategies to reduce inputs from Canada, or the local watershed, or distant industrial areas within the U.S. if they knew the relative importance of inputs from these source areas. The existing LaMPs for all of the lakes direct most effort towards identifying (and reducing) usage of the PBTs within each lake basin. This effort will have very little effect if the vast majority of the PBTs are derived from long-range transport. This project proposes to determine the fraction of the PCB input to L. Superior that is derived from local and distant sources.

An important component of the LaMPs has been establishment of the Integrated Atmospheric Deposition Network (IADN) for monitoring of atmospheric deposition of pollutants into the Great Lakes. However, the protocols for sampling of pollutant concentrations and calculation of atmospheric deposition rates are based on an overly simplistic parameterization of gas exchange that ignores meteorological conditions above the lake. We suggest that the current strategy may be in error by more than a factor of two.

The proposed project is aimed at determining the relative contributions of the different sources for PCBs that actually enter Lake Superior during the period May-September. The work is predicated upon the assumption that the majority of gas exchange occurs during periods of unstable atmospheric surface layers above the lake. During the period May-September, air flowing over land is warmer than the lake water. As a result, a stable inversion develops over the lake that prevents air that blows offshore from actually contacting the lake surface. The land air is lofted above the stable surface layer that overlies the lake. This phenomenon is well-documented over the Great Lakes and coastal oceans. However, whenever low pressure systems move across the lake, the stable surface layer of air is disrupted, and land-derived air can then contact the lake surface. We postulate that the majority of gas exchange occurs in pulses during the passage of synoptic weather fronts. Hence the concentrations of PBTs and the origins of the air masses during the passage of these low pressure

fronts are critical factors determining both the magnitude of the gas inputs to the lakes and the sources of the PBTs that enter the lakes.

**Proposed Work Outcome:**

The proposed work plan has two components. First, we propose to test the hypothesis that the majority of gas exchange occurs during passage of low pressure systems over the lake. Gas phase concentrations of PCBs will be measured on 20 occasions at 1-m height above the lake surface; half of these measurements will be made during periods of stable surface layers, and half will be made during periods of unstable (mixed) atmospheric conditions. Dissolved phase PCBs also will be measured to allow calculation of gas fluxes into the lake. The hypothesis predicts that the majority of gas exchange will occur during periods of unstable air above the lake surface. Second, we propose to determine the source of the air masses during periods of unstable over-water air by back trajectory analysis. Using the method of Subhash et al. (1998), we shall also compare the magnitude of the gas phase PCB concentrations relative to expected concentrations during periods of stable and unstable atmospheric surface layers. For the trajectory analyses and comparison of concentrations, we are not limited to the 20 measurements to be made in this study; the entire IADN data set for Eagle Harbor, MI will be analyzed in this fashion.

The outcomes of the project will be (1) a critical improvement in our understanding of gas fluxes to all of the Great Lakes that may necessitate recalculation of gas fluxes of SVOCs to all lakes as well as a new strategy for monitoring of inputs; (2) an improved estimate of the rate of input/output of PCBs via gas exchange to L. Superior; (3) a partitioning of the sources of PCBs to L. Superior among local, Canadian, mid-western U.S. and other long-range sources.

| **Project Milestones:** | **Dates:** |
|---|---|
| Project Start | 09/2000 |
| New anal. methods developed | 03/2001 |
| Proof of theory | 08/2001 |
| Source of inputs to Superior for 1999 | 12/2001 |
| Historical source apportionment | 08/2002 |
| | / |
| | / |
| Project End | 08/2002 |

☐ Project Addresses Environmental Justice

**If So, Description of How:**

☐ Project Addresses Education/Outreach

**If So, Description of How:**

**Project Budget:**

| | Federal Share Requested ($) | Applicant's Share ($) |
|---|---|---|
| **Personnel:** | 37,742 | 0 |
| **Fringe:** | 2,331 | 0 |
| **Travel:** | 2,500 | 0 |
| **Equipment:** | 18,000 | 0 |
| **Supplies:** | 12,000 | 0 |
| **Contracts:** | 0 | 0 |
| **Construction:** | 0 | 0 |
| **Other:** | 16,692 | 0 |
| **Total Direct Costs:** | 89,265 | 0 |
| **Indirect Costs:** | 29,558 | 0 |
| **Total:** | 118,823 | 0 |
| **Projected Income:** | 0 | 0 |

**Funding by Other Organizations (Names, Amounts, Description of Commitments):**

Grants are currently pending with NSF and the Great Lakes Protection Fund that will augment this study. Those projects are not aimed at source apportionment nor improvements in monitoring strategies, however. The projects will, if approved, provide ship time for the limited sampling proposed in this study.

**Description of Collaboration/Community Based Support:**

As part of the grants currently pending with NSF and the Great Lakes Protection Fund, we have proposed collaboration with scientists at Argonne National Laboratory and Michigan State University to elucidate the interactions between rates of atmospheric deposition and meteorological conditions. Those projects will not, however, have the monitoring component proposed here nor the specific deliverables of most use to managers in the Great Lakes.